[redacted]

COPY

24 December 1963
LEC:mb-770

Chief, Office of Naval Research
Department of the Navy
Washington 25, D. C.

Attention: [redacted] Geography Branch STAT

Subject: [redacted] Perception Concepts to Photo-Interpretation

Dear Sir:

In accordance with your letter of 28 October 1963 to our [redacted] we are pleased to provide you with the information requested concerning the financial status of this contract: STAT

As of 1 December 1963

[redacted] STAT

Commencing with submittal of the next monthly report, our transmittal letter will contain financial information in the above format.

Very truly yours,

[redacted] STAT

[redacted] STAT

Contract Administrator

cc: ONR, Washington, D. C. STAT
[redacted]

STAT

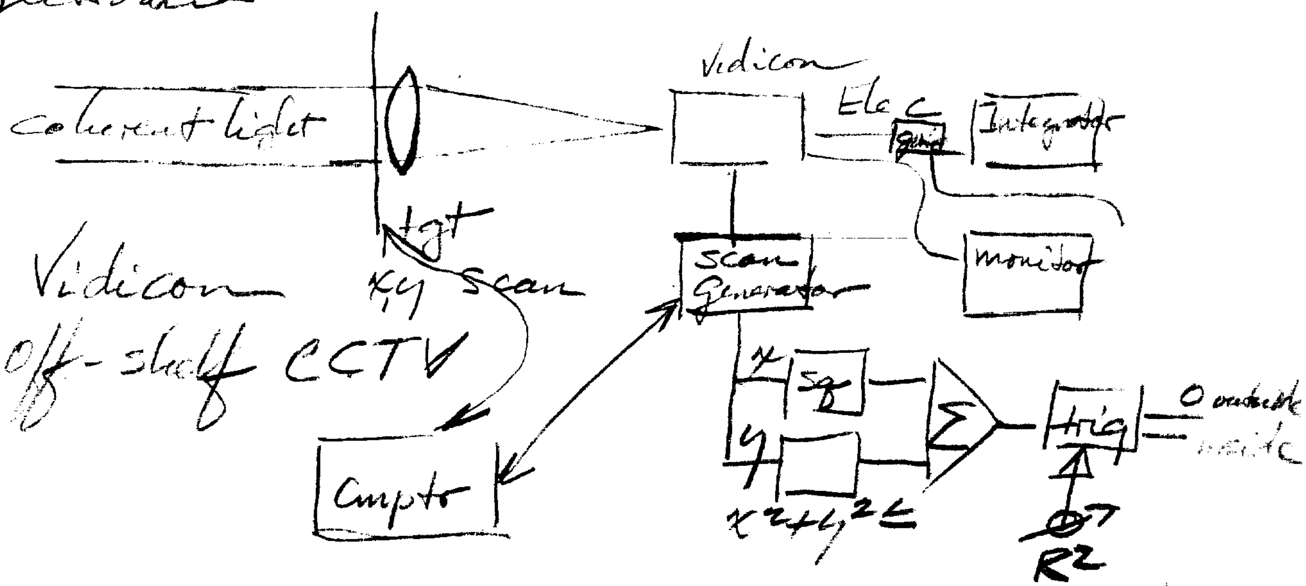
STAT

File

6 Dec 1965

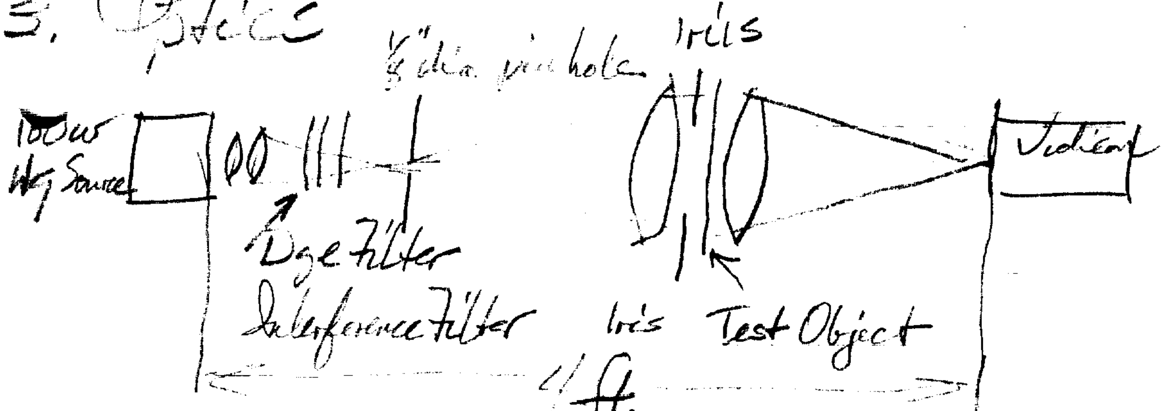
1. Progress Reports - Finance

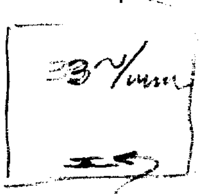
2. Electronics



a. Vidicon xy scan
b. Off-shelf CCTV

3. Optics





Lateral position and rigidity important

1/2 to 1/3 l/mm spot size

Slow Scan w/ high persistence monitor

Spectrum distortion due to irregularities in emulsion thickness. Dust

2/.

[redacted] STAT

6 Dec 63

Indexing System based on duplicate exposure

Prompt visit by [redacted] STAT

Good Growth Potential

Not possible to get unique signatures on all basic object types

STAT [redacted] for the system

~~time~~ 6 months

Residue of current contract [redacted] STAT

1. detection — long range → total comprehension
2. isolation
3. standardization — System would be gov't property
4. recognition

P. O. Box 2143
Main Post Office
Washington, D.C.

26 November 1963

STAT

[redacted]

Head, Computer Research Department

Reference: ONR PICS Contract

Enclosed are additional unclassified photographs for use in Project PICS.

Since this particular assortment of images was difficult to locate, we were unable to hold to a 1:5000 scale and had to accept a range of scales.

Included are:

1. More Railroads: negatives and positives, scale 1:5000 and 1:2,500
   Railroads and Wave Patterns: negatives and positives, scale 1:5000

2. Uninhabited Land: negatives and positives, scale unknown

3. Wave Patterns: Prints, scale 1:5000

4. Examples of Change: 1 negative and 1 positive -- Effects of hurricane March '62 (notice ship aground)
   1 negative -- same area, December '61
   3 positives of the same area -- August '57 and March '62 (notice bridge improvements, seasonal changes)

5. Airfields: Positives, scale 1:20,000

We have found some clearcut examples of change in photographs of urban areas and will soon send these along.

Unfortunately, we cannot supply you with examples of radar and infrared photography since nothing is available on an unclassified basis.

Very truly yours,

[redacted]

STAT

the "window" in the earth's atmosphere through which IR rays pass without being absorbed. Consequently, this range is the best choice for IR mapping of the earth's surface by satellite (and, although not mentioned as such, for IR surveillance).

The Westinghouse IR triplet lens system was computer designed using a new programming technique devised by D. S. Grey of MIT, and is essentially diffraction limited over its 12-degree field of view. The only sharpness limiting factor in this case is the spread of IR waves at the lens opening itself. By producing the new f 0.75 IR lens system, two full stops have been gained over previous IR lenses which normally operated at f 1.5 — a great boon for viewing weak IR sources.

Molehills from mountains

A fascinating and controversial survey of the automatic extraction of pertinent information from great quantities of film in non-numeric data processing was presented by a panel under the chairmanship of Dr. Robt. J. Potter of IBM, consisting of Dr. Paul V. C. Hough of Brookhaven National Labs, H. F. Mansberg of Airborne Instruments Lab., Dr. Geo. Sebestyen of Litton Systems, and Helen Gustafson of the Nuclear Research Institute.

Potter said in his introduction that the objective of the panel was to discuss "the technical details of non-numeric data processing with emphasis on pictorial or graphical input data. The approaches are somewhat different, but all have the net result of doing data processing, in large, high-speed computers, of information which is not in a suitable form to be used as direct input to the computing machine."

The field of automatic data processing, according to the panel, is still in its infancy and there is a great need to develop methods which can discover pertinent data before actually processing and measuring such data on the film. The controversial part of the discussion concerned not the need for better and faster data processing machines and methods, but the feasibility of programming machines to do qualitative interpretation to make decisions as to what

Approved For Release 2005/05/02 : CIA-RDP78B04770A002300030006-9

information to extract from which frames of film.

In the case of plates used in astronomy, and even in the case of bubble-chamber photographs, all dealing with minute traces of images on only a few of a multitude of frames, the problem does not seem insurmountable. However, when it comes to scanning and interpreting subjects such as aerial-reconnaissance footage, the question of machine-made decisions becomes controversial. You can program a computer device to spot aircraft, missiles, trucks, cars and other acceptable subjects on an aerial photograph, but how would the computer manage to discover objects as yet unknown objects with unknown shapes, and which consequently cannot be pre-programmed into the device's memory?

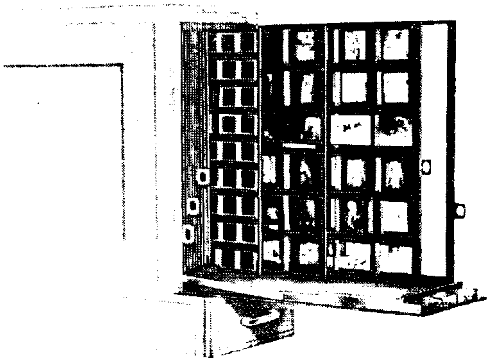
Spotting the unknown V2

An old example from World War II comes to mind, when an alert RAF photo-interpreter (human, female) spotted the first German V2 missile on a launching pad at a time when missiles per se were unknown. We are sure that had a programmed computer been studying the photos, looking for everything but the then-unknown missiles, the machine would have happily passed this picture through!

Nevertheless the panel gave a fascinating insight into the state of the arts of the whole data-processing field which is fast becoming more and more automated, due to the fantastic amount of film to be digested and interpreted and plotted.

To give an example of the magnitude of the effort, Hough mentioned that a typical bubble-chamber experiment results in 100,000 triads of exposures (triple photos, through a tri-stereo camera). Using the conventional measuring machine, a measuring projector called a "Franckenstein" (after J. V. Franck of the Berkeley Radiation Lab), in one 8-hour work shift only 20-30 events can be measured for the two or three views required. This has led the larger labs to set up as many as a half-dozen Franckensteins and two-to-three work shifts per day to man them.

Hough also reported on a high-resolution, high-precision mechanical Flying Spot Digitizer, (FSD) developed by him and B. W. Powell, working at CERN, Geneva, Switzerland, operating on-line to an IBM 7094 computer, which greatly speeds processing of vast volumes of data. Complete FSD systems at



the University of California at Brookhaven currently are processing strange-particle events at about the rate of 10 conventional measuring machines. A greater expansion of rate is envisioned for the near future. The Mark II FSD at Brookhaven is capable of a resolution of 10 microns and an accuracy of 1-2 microns over a 2x6-inch area of a photographic negative.

Dr. Potter described an experimental Optical Character Scanner used for recognition of characters. The OCS optically scans a 35mm microfilm transparency and provides binary information for the rest of the character recognition system. The system, at present a research tool and not intended as a prototype for a commercial recognition machine, is capable of searching, centering and normalizing its raster on a line of text before reading. The OCS and its associated recognition equipment is being used to study various aspects of character recognition problems at IBM's Thomas J. Watson Research Center in Yorktown Heights, N. Y.

Identify with parameters

George Sebestyen of Litton Systems delivered another of the controversial papers, subheaded "Automatic Target Recognition." Of three different approaches to the problem, he considered the parametric approach as the most promising for future development. In this method the photograph is scanned, "in a systematic manner to cover each and every cell so that it may be examined for target content. The content of the cell is then characterized by a parametric description in which each parameter is a measure of an attribute, and the set of attributes (their quantitative values) are used to describe the contents of each cell.

"Thus we may obtain a description of a cell as one which exhibits a large dynamic range of contrast, a large number of elementary picture details of circular shape, a dominance of only a few densities, a uniform spacing between detail elements, etc. If the descriptors are well chosen this could sufficiently well describe a tank farm and would permit its discrimination from other target types." Sebestyen also acquainted his audience with the various shortcomings of different systems, but left the distinct impression that he does not consider the shortcomings unsurmountable. E. E. RESHOVSKY aerial photography range in thickness from 0.060 to 0.250 of an inch, can be made to deviate only two millionths of an inch per inch from a true flat plane and are available from 15x60mm to 12x12 inches.

So, let's not relegate the photographic glass plate to the age of flash powder and lens-cap photography, which incidentally are also making "come-backs" more about *that* in a future column.

NASA plans moon photo orbits

• NASA has asked for proposals on a moon photo orbit project planned by 1966. As a prelude to manned landings on the moon, five photographic satellites will be placed in a low lunar orbit to gather information on characteristics of the lunar terrain. NASA said that the photographic lunar satellites will be orbited as low as 22 miles above the moon's surface, and will be instrumental in selecting Apollo landing areas.

The design objective for the lunar photo system is to retrieve from the satellites photographs which will delineate lunar surface features on the order of 10 feet and, with the higher orbits, map surface segments up to 15,000 square miles. The close-up pictures must be able to identify flat areas of no more than 25 feet square, the area required for landing a two-man moon capsule. In addition to a check on landing areas, the photo satellites are expected to provide new information about the shape of the moon and the distribution of its mass.

Results from the orbital photo project should settle once and for all the question still under discussion amongst scientists: Is the surface of the moon covered with a layer of dust into which a landing craft might sink helplessly?

High-speed camera under $1000

• Over a period of several years we have watched with fascination the gradual improvements and development of the "Volkswagen" among the high-speed motion picture cameras: Red Lake Labs' HYCAM.

Starting with a pieplate-cover prototype (which worked fine) this piece of equipment has been improved without any ballyhoo by its manufacturer and without the usual price jump, so that today we have in the HYCAM a handsome piece of equipment at a most attractive price tag (just about $1000 per camera) capable of an operating range from 200 to 6000 fps, without accessories; a range which can be extended, if necessary, by the user himself, from 10 to 8,500 fps.

A rotating prism camera, the HYCAM designers simplified it by the elimination of all gears and putting the film transport sprocket and the rotating prism on the same drive shaft, which also carries the segmented shutter. This approach did away with gear backlash and bearing run-out, both of which have always been difficult and expensive to overcome. The same two factors also have in the past plagued designers with the problem of steadiness.

Yes, we are enthused about the approach used across-the-board by the designers of the HYCAM, because it's a piece of equipment one can easily become enthused about. For more details, drop a line to the small, but progressive Red Lakes Labs, at 564 San Xavier Ave., Sunnyvale, Calif. 94086.

Lasers for optics evaluation

• Lasers are now being used for inspection and evaluation of thick lenses and prisms with precision interferometers at Perkin-Elmer Corp. Mercury lamps, a previously used source of intense light, never put out enough light to apply this method of inspection to glass thicknesses greater than one inch. [See photograph on page 58 Ed.]

Using a Twyman-Green type of interferometer with a gas-phase laser as a source of brilliant, continuous light, technicians at Perkins-Elmer have observed fringe patterns indicative of optical homogeneity in paths as long as 14 inches in large prisms, and there seems no limitation of the gas-phase laser technique by optical components of any practical size.

The laser used at P-E emits light of 6328 angstroms, a red, narrow pencil beam of great intensity. An intensity control and a neutral-density filter are used to bring the light to an acceptable level for both visual and photographic use by means of a Polaroid Land camera.

In this type of inspection the technician observes the parallelism of interference fringes in the interferometer eyepiece. Perfect optical qualities would be indicated by exactly parallel fringes. Variations in the index of refraction or in optical homogeneity of optical components or systems can be checked with the laser without the use of a known compensating disk in the comparison light beam. Also, parallel planes in plates of great thickness can be measured for optical variation.

P. O. Box 2143
Main Post Office
Washington, D.C.

9 October 1963

STAT

[redacted]
Head, Computer Research Dept.

REFERENCE: ONR PICS Contract

Enclosed are photographs of various images which should be helpful in the PICS Project. In total they cover the categories of: shipping, harbors, rail traffic, tanks, buildings, open ocean, uninhabited land. We are still in the process of locating and selecting examples of change, airfields, infrared and radar photography: we will send these along as soon as possible.

The transparencies are film positives whose scale is 1:5,000 (except for two exposures which are examples of infrared and whose scale is 1:6,000). For the most part we are supplying you with consecutive, paired images for use in stereo if desired.

The prints represent a variety of scales which you can relate to the 1:5,000 standard we have attempted to keep. These were obtained from a variety of sources and specific information was not available.

The film positives were procured from Coast and Geodetic Survey and we suggest you contact them if you need additional material.

Sincerely yours,

[redacted]

STAT

Enclosures: A/S

PHOTOGRAPHIC REQUISITION

OFFICE/DIVISION/JOB NO: P&DS 76/63	DATE DELIVERED TO REQUESTER:
PRIORITY: ASAP	PROJECT NO:
JOB NO: 64-3412	
DATE RECEIVED IN PHOTO CONTROL:	PHONE: [redacted]OM NO: 4N-41 STAT
DATE SUBMITTED: 8 OCT 63	ORDERE[redacted] STAT
DATE REQUIRED: 10/11	

TYPE	MATERIALS	NO. ORIGINALS	NO. COPIES EACH	TOTAL
CONTACT	GLOSSY PAPER			
	SEMI GLOSS PAPER			
	MATT PAPER			
	FILM POSITIVE			
	FILM NEGATIVE	2 (negs)	1 each	2
ENLARGE	GLOSSY PAPER			
	SEMI GLOSS PAPER			
	MATT PAPER			
	FILM POSITIVE			
	FILM NEGATIVE			
COPY	NEGATIVE			
	POSITIVE			
	OTHER			
PROCESSING	FILM			
	POSITIVE			

CLASSIFICATION:

REMARKS AND/OR INSTRUCTIONS: FRAMES ARE MARKED WITH MASKING TAPE + ARROW (FRAMES ARE IN MIDDLE of ROLL + ARE CONSECUTIVE — around 2315-2311).

MATERIAL FURNISHED

CONTROL NO.	EXPOSURES FROM	EXPOSURES TO	NO. EACH	CONTROL NO.	EXPOSURES FROM	EXPOSURES TO	NO. EACH	CONTROL NO.	EXPOSURES FROM	EXPOSURES TO	NO. EACH

Received By

NPIC FORM 20 (REV 4/63)

Please use typewriter or ball point pen.

PHOTOGRAPHIC REQUISITION

OFFICE/DIVISION/JOB NO: P & DS 78/63	DATE DELIVERED TO REQUESTER:

PRIORITY: ASAP	PROJECT NO:	JOB NO: 64-3413

DATE RECEIVED IN PHOTO CONTROL: [redacted] OOM NO: 4N-41 STAT

DATE SUBMITTED: 8 OCT. 63 ORDERED [redacted] DATE REQUIRED: 10/11 STAT

TYPE	MATERIALS	NO. ORIGINALS	NO. COPIES EACH	TOTAL
CONTACT	GLOSSY PAPER			
	SEMI GLOSS PAPER			
	MATT PAPER			
	FILM POSITIVE			
	FILM NEGATIVE	4 (negs)	1 each	4
ENLARGE	GLOSSY PAPER			
	SEMI GLOSS PAPER			
	MATT PAPER			
	FILM POSITIVE			
	FILM NEGATIVE			
COPY	NEGATIVE			
	POSITIVE			
	OTHER			
PROCESSING	FILM			
	POSITIVE			

CLASSIFICATION:

REMARKS AND/OR INSTRUCTIONS:

MATERIAL FURNISHED

CONTROL NO.	EXPOSURES FROM	EXPOSURES TO	NO. EACH	CONTROL NO.	EXPOSURES FROM	EXPOSURES TO	NO. EACH	CONTROL NO.	EXPOSURES FROM	EXPOSURES TO	NO. EACH

Received By

NPIC FORM 20 (REV 4/63)

Please use typewriter or ball point pen.

STAT

14 October 1963
GER:pjw-29

Work Outline for Project PICS

Introduction

The results obtained so far on Project PICS suggest that an operational aid to the human photo-interpreter may be possible much sooner than had been previously expected. There is very real hope that properties derived from the power spectrum of a picture segment can be used as input to a pattern recognition device to accomplish one or more of the following:

1) Screening - separation of sterile photographs from those containing areas of potential interest to human photo-interpreters.

2) Inventory - detailed examination of a single photograph to count objects of a specific target class.

3) Rescanning - selection of photographs which contain a specific target known only from one example.

The major project activities are thus to be directed toward examination of the spectral properties of picture segments, and of the recognition techniques required to make effective use of them. The feasibility of an optical-electronic device which measures spectral properties will be determined. Such a device would be a valuable tool in carrying out these investigations, and could also serve as a first laboratory model of an operational device. In addition, activities of a more speculative nature are provided for.

Program Elements

A program aimed at early operational utility, with a reasonable amount of research in areas of longer-term significance is presented in four parts as follows:

1. Property Evaluation

We are here interested in determining the nature and value of the properties which can be extracted from a segment of a photograph by means of optical spatial filters. Three approaches are possible and it is likely that all three will be used with the choice in any particular instance depending upon cost and ease of experiment.

These are:

a) analysis

b) digital computer experiments

STAT c) experiments using [redacted] optical spatial filtering apparatus.

The properties to be studied are those which can be derived by the following sequence of operations:

a) segment selection

b) band-pass filtering (at full image resolution)

c) detection

d) low-pass filtering.

The output of the low-pass filter is a measure of the energy in the original picture in the frequency band passed by the band-pass filter. It is also possible to obtain similar results by doing the segment selection after the low-pass filtering. The choice depends upon experimental and operational convenience, and upon the desired frequency resolution.

2. Recognition Studies

Given that the properties extracted by the techniques described above contain sufficient information to effect the desired classification, there still remains the problem of designing and economically implementing a recognition system which will perform this classification. Previous work on this and related projects strongly suggests the use of adaptive techniques for the design. An important early study should examine the relative virtues of randomly-connected recognition logic and more conventional Bayesian decision functions in the context of the property types available and the desired classifications. Some work along these lines is already in progress in Project PICS.

The major investigative tool for this effort will be a large-scale digital computer, using programs already developed on PICS, and such new programs as may be required.

3. Design of Optical-Electronic Spatial Filtering Equipment

As a result of discussions in Buffalo and Washington, (with important

STAT suggestions from [redacted] an optical-electronic machine of considerable potential power in both the investigation and application phases of this project has evolved. Available project funds can readily support a detailed design which will establish feasibility, determine performance ranges and limitations, and provide estimates of cost and construction time.

In a form suited to laboratory investigations, the device (Figure 1) consists of the following optical train:

a) a source of parallel mono-chromatic light.

b) an adjustable aperture which selects the size of the picture segment to be analyzed.

c) a holder for the film frame to be analyzed, movable to select the segment position.

d) a converging lens to take the Fourier transform of the selected segment.

e) a television-type photo-sensitive device placed at the focal plane of d).

f) scan-generation electronics, an output integrator, and display oscilloscope.

Since the output device is placed at the focal plane of the transformation lens, the power spectrum of the selected picture segment is directly available. Integration of this spectrum over any region of the two-dimensional frequency plane is possible by the use of standard electronic scanning techniques. Thus, the nature of the filter used can be varied by varying the scanning program. Dynamic adjustment by an operator while observing a display is possible. In addition, the output of a single filter from various picture segments can be readily observed.

In an operational application, a more elaborate scanning program can produce, in time sequence for a given area, the outputs of many filters. These can then be the inputs to a recognition device for classifying the area being examined.

The device as described has considerable growth potential, both as a laboratory device, and in application. One such possibility is the use of automatic control of the segment-selection apparatus as a result of previous recognition outputs. This would make possible various attention-centering, edge-tracing, and ribbon-following operations.

Early availability of this device in the laboratory can greatly accelerate progress on the project, and should materially shorten the time to operational application.

4. Long-Term Research

This program element is provided to accommodate research ideas which are not well enough developed to permit prediction of operational utility on any time scale, but which have enough long-term promise to warrant investigation.

Some possibilities include:

a) use of shadows for attention centering.

b) use of the curvature of brightness contours as clues to man-made objects.

c) recognition directly from the gray-scale image.

d) attention centering through low-resolution peripheral processes.

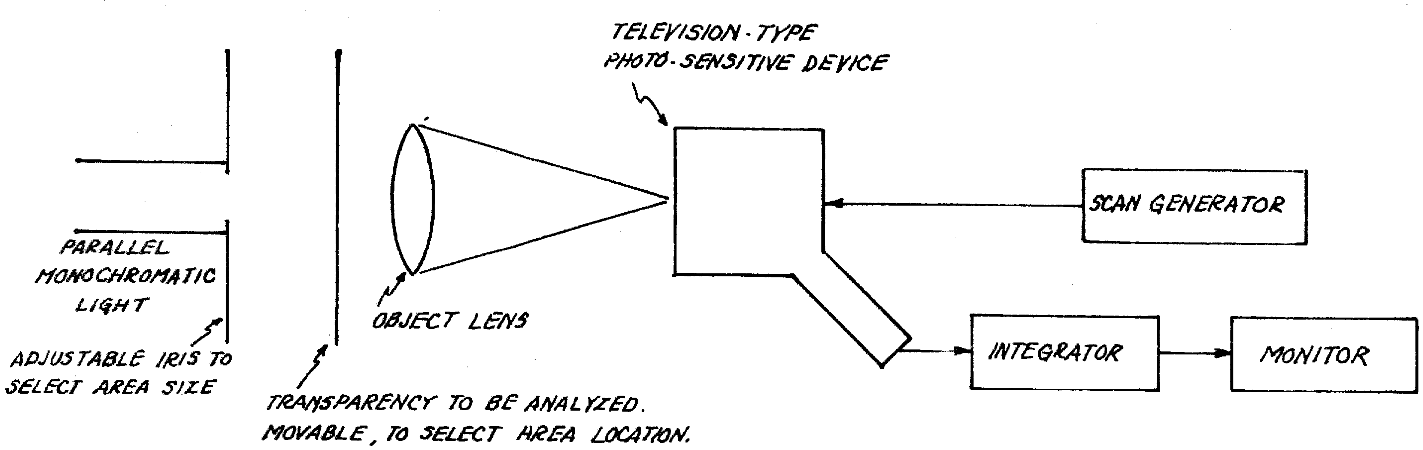


Figure 1. OPTICAL-ELECTRONIC SPATIAL FILTER

File

PROJECT PICS CONFERENCE 2 October 1963

STAT

PERCEPTRON CONTRACT

Agenda

1. Digital VS Analog

    1.1 The natural bias

    1.2 The time

    1.3 The cost

2. Categories of Image Recognition Task

    2.1 Whole Frame Classification

        2.1.1 Interesting

        2.1.2 Sterile - W/O works of man

    2.2 Inventory

        2.2.1 Aircraft

            2.2.1.1 Types

        2.2.2 Shipping

        2.2.3 Rail Traffic

        2.2.4 Tanks (storage)

        2.2.5 Buildings

        2.2.6 Armament

        2.2.7 Ad Infinitum

    2.3 Rescanning

    2.4 IR Images

    2.5 Radar Images

    2.6 Change Detection

3. Problem Areas

   3.1 Shadows

   3.2 Distortions

   3.3 Bandwidth

   3.4 Context

4. Perceptron VS Special Purpose Devices

   4.1 Probability of Perceptron Application

      4.1.1 Which realms

   4.2 Other Approaches

5. Spatial Filtering

6. Implementation

Project PICS Conference, Sept. 17 and 18, 1963

STAT

[redacted]

Agenda

Subject

Agenda

Project History

Summary of project effort thru 1962

Objectives of Current Work

- Project Objectives
- Operational Employment Discussions

Accomplishments of Current Work

- Object Detection
- Whole-Photo Classification
- Recognition
- Implementation

Equipment Development

Related Programs

- TARCOG
- Linear Discriminator

Joint Meeting with Sponsors of Project CHARM

An equipment demonstration is scheduled for 4:30 P.M., Sept. 17. This will include:

1) Facsimile input equipment
2) One filtering demonstration
3) Facsimile output equipment
4) Flying spot scanner input-output equipment (under development)

STAT

[redacted]

STAT

[redacted]

Chief, Office of Naval Research
Department of the Navy
Washington 25, D.C.

STAT

Attention: Code 414, [redacted]

Dear Walter:

Attached is the work outline which we plan to follow in carrying out the recently funded extension of our PICS Project. The plan was developed in a series of meetings here involving Mort, Bill, and myself, and guided primarily by several rough drafts prepared by [redacted] What we have tried to develop is a nine month program plan which is responsive to our own technical interests and capabilities and, at the same time, to our best interpretation of the Navy's several objectives in sponsoring research in this area. There are four major elements in our work plan, and I thought a few general remarks on each may be worthwhile.

STAT

The idea of whole photo classification as an early or preliminary step in photointerpretation certainly is an interesting and challenging one to try to automate. We have a number of ideas as to how one can go about this, some of which we described in our meeting here with you. Others that appear in our project outline have been generated since.

We have given a good deal of thought to, and have had a lot of discussion on, that part of our program which will deal with pattern recognition in perceptrons and related self-organizing systems. In stating our objective here, we have included several different experiments, although we don't anticipate being able to do all of the examples listed. We want to weigh the cost of these experiments against their general value in terms of providing a better understanding of pattern recognition capability before we make a final decision.

The third item, the work on object detection, is directed toward the same type of long term goal toward which our work of the past two years has been directed. I think we are all agreed on the value of continuing object detection work, particularly by trying some additional techniques which we have conceived, but not yet evaluated.

STAT [redacted]

5 July 1963

In the area of implementation we believe that we can sufficiently define several classes of pictorial filtering techniques which might be used in whole photo classification, as well as in object recognition, to make it sensible to go ahead at this time with trying to learn how to implement these general classes of techniques. For example, we are confident that spectrum filtering, thresholding, and similar operations are quite likely to be involved in early devices as well as in those of later generations.

We would be more than happy to have comments from you, from STAT [redacted] and other interested parties, particularly of course if there is any feeling that we may have misinterpreted or reacted too strongly to ~~in~~ any of the discussions during our recent meeting in Buffalo. We think the program as it stands is an excellent one, and we are proceeding with the work in the technical area of spectrum analysis for use in both whole photo classification and object detection.

I have not yet received the photointerpretation keys which your last letter said you were sending under separate cover. They may be lost in our mailing system, so I suggest we wait another week or so before trying to follow up.

STAT

[redacted]

HRL-66:ces

Attachment

 STAT

5 July 1963

Work Outline for Project PICS

Introduction

There will be four areas of technical concentration: (1) Whole-Photo Classification, (2) Recognition, (3) Object Detection, and (4) Implementation. For each of these, we state a long-term objective (what we eventually hope to achieve), one or more short-term objectives (things which we can reasonably hope to achieve during the current contract period), and technical approaches to the short-term goals.

(1) Whole-Photo Classification

Long-Term Goal: Automatic scanning of large quantities of aerial photographs to remove those which are sterile; such as photos of cloud cover, empty ocean, or those containing no works of man.

Short-Term Goal: Invention, analysis, and trial of at least one technique on at least one type of discrimination, such as empty ocean vs ocean containing ships.

Technical Approaches:

1. Investigation of the implications of sub-dividing the photo into areas which are treated separately, and of methods for combining the results.
2. Analysis, with experimental trial where indicated, of some of the following classification schemes:
   - a) Simple perceptron applied to small sub-areas in an attempt to detect "unnatural" features.
   - b) Contour and curvature detection.
   - c) Spectrum analysis
   - d) Auto-correlation analysis

   - e) Simple perceptron used as a technique for combining outputs of property detectors like the above.

2 Recognition

Long-Term Goal: Provide recognition apparatus which will become a part of an automated photo interpretation system.

Short-Term Goal: Perform analysis and experiments leading to a better understanding of a perceptron as a two-dimensional pattern recognition device, especially with respect to the trade-offs among sensory to association unit connection density, organization of these connections, and number of association units.

Technical Approaches: Using synthetically-generated patterns, perform experiments chosen from among the following:

1. Parametric study of connection density vs number of A-units at constant recognition performance.
2. Study of the value of highly-constrained connections (e.g., objective properties).
3. Study of degradation of performance under pattern translation and rotation.

3 Object Detection

Long-Term Goal: Automatic analysis and classification of aerial photographs by means of detection and recognition of the objects which they contain.

Short-Term Goal: Invention, implementation, and test of new object detection techniques.

Technical Approaches: The major new detection technique which is to be investigated is a spectrum consistency test.

4 Implementation

Long-Term Goal: Construction of a device which can realize the long term goals of object detection and whole-photo classification as outlined above.

Short-Term Goals:

1. Identification of techniques which may be useful in performing the procedures required.
2. Laboratory investigation of one or more such techniques.

Technical Approaches:

1. Investigation of the capabilities and limitations of optical filters in the performance of linear and non-linear operations.

2. Investigation of new or unconventional processing techniques, such as:

   a) photo-plastic films

   b) Ferro-electric plates

   c) Electroluminescent elements

   d) Photo-chromic films